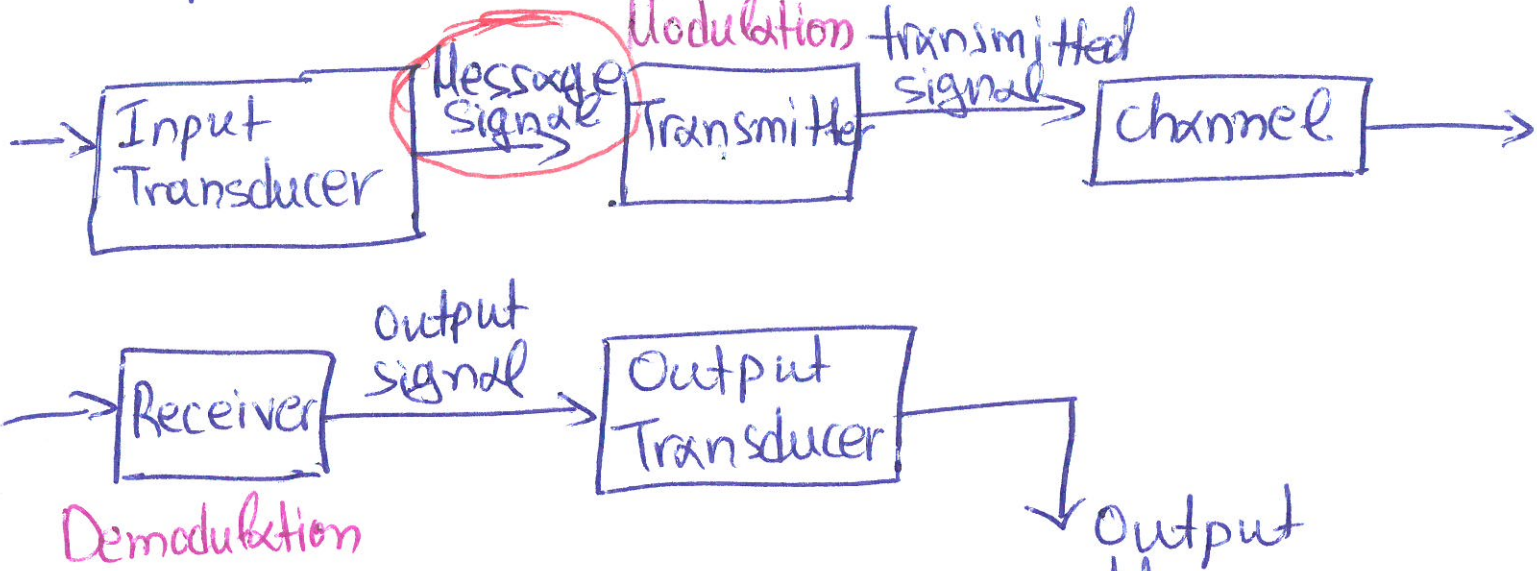
Analog

telephone

Digital

telegraph



Noise → external

→ internal

Types of channels → electromagnetic-wave propagation channels

→ optical channel.

→ guided electromagnetic-wave channels

Message signal: $m(t)$

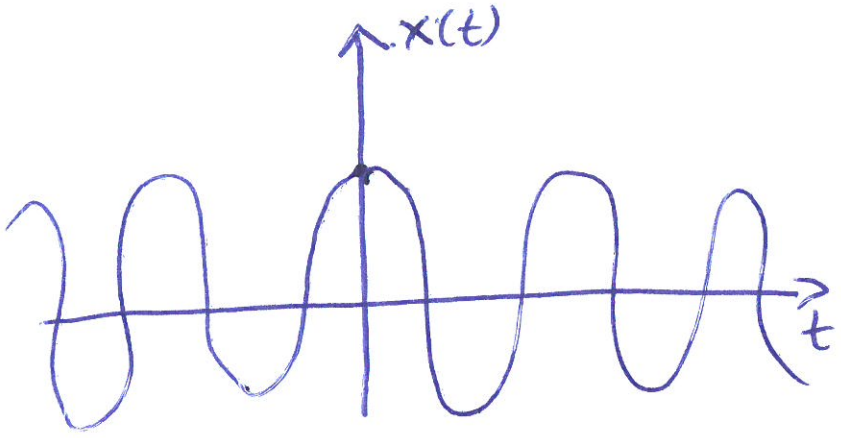
Modulated carrier signal: $x_c(t) = A_c\, m(t) \cos(\omega_c t)$

(A_c: amplitude, ω_c: carrier frequency)

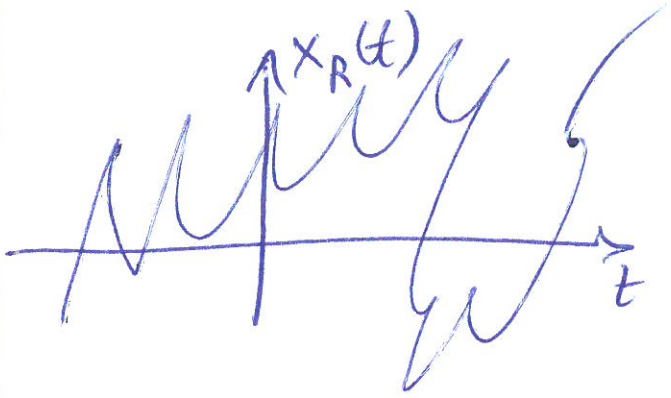
Signals

Deterministic

$x(t) = A\cos(\omega_0 t), \quad -\infty < t < +\infty$

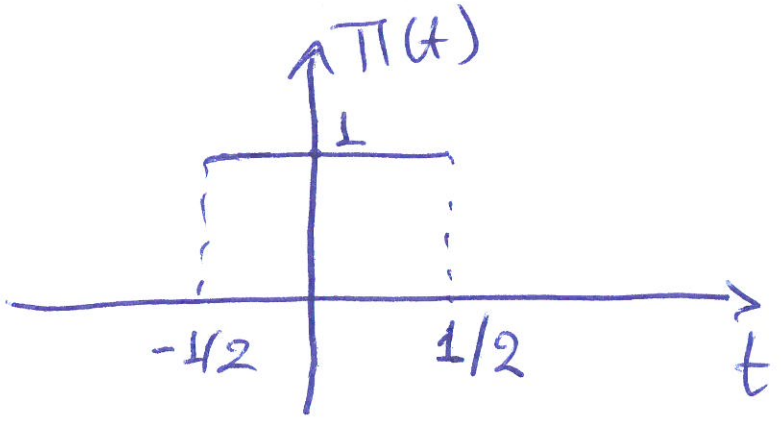


Random



Unit Rectangular Pulse

$$\Pi(t) = \begin{cases} 1, & |t| \leq \frac{1}{2} \\ 0, & \text{otherwise} \end{cases}$$



Signals

Periodic

$$x(t+T_0) = x(t)$$

$$-\infty < t < +\infty$$

Rotating Phasor

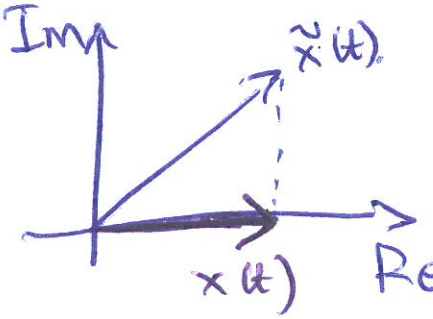
$$\tilde{x}(t) = A \cdot e^{j(\omega_0 t+\theta)}$$

$$-\infty < t < +\infty$$

$$T = \frac{2\pi}{\omega_0}$$

$$\tilde{x}(t) = A\cos(\omega_0 t+\theta) + jA\cdot\sin(\omega_0 t+\theta)$$

$$x(t) = \mathrm{Re}[\tilde{x}(t)] = A\cos(\omega_0 t+\theta)$$



Aperiodic

Singularity function

Unit Impulse-Delta function

$$\int_{-\infty}^{+\infty} x(t)\cdot\delta(t)dt = x(0)$$

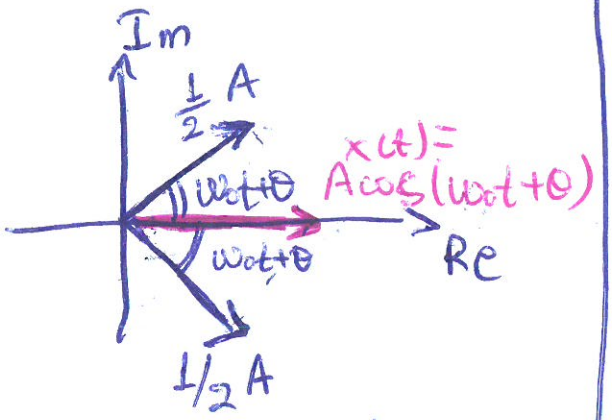
Shifting Property

$$\int_{-\infty}^{+\infty} x(t)\,\delta(t-t_0)dt = x(t_0)$$

$$\int_{t_1}^{t_2} \delta(t-t_0)dt = 1.$$

$$(t_1 < t_0 < t_2)$$

$$e^{j(\omega_0 t+\theta)} = \cos(\omega_0 t+\theta) + j\sin(\omega_0 t+\theta)$$



$$x(t) = A\cos(\omega_0 t+\theta)$$

$$\left(= \frac{1}{2}\tilde{x}(t) + \frac{1}{2}\tilde{x}^*(t)\right)$$

$$= \frac{A}{2}\cos(\omega_0 t+\theta) + \frac{A}{2}\cos(\omega_0 t+\theta)$$

$$= \frac{A}{2}\cos(\omega_0 t+\theta) + \frac{A}{2}\cos(\omega_0 t+\theta) + j\frac{A}{2}\sin(\omega_0 t+\theta) - j\frac{A}{2}\sin(\omega_0 t+\theta)$$

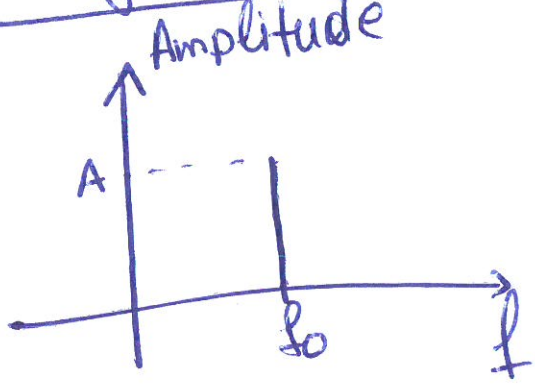
$$= \frac{1}{2}\tilde{x}(t) + \frac{1}{2}\tilde{x}^*(t)$$

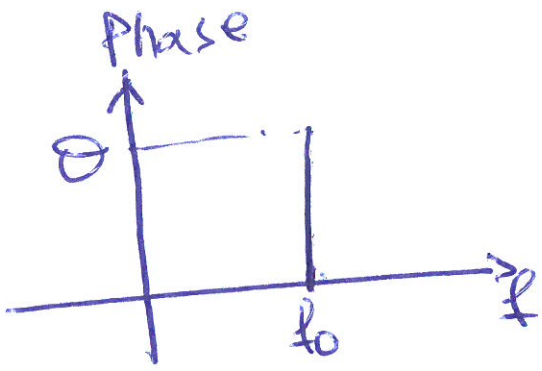
Line Spectra

- Amplitude
  - Single-sided ($f > 0$)
  - Double-sided
- Phase

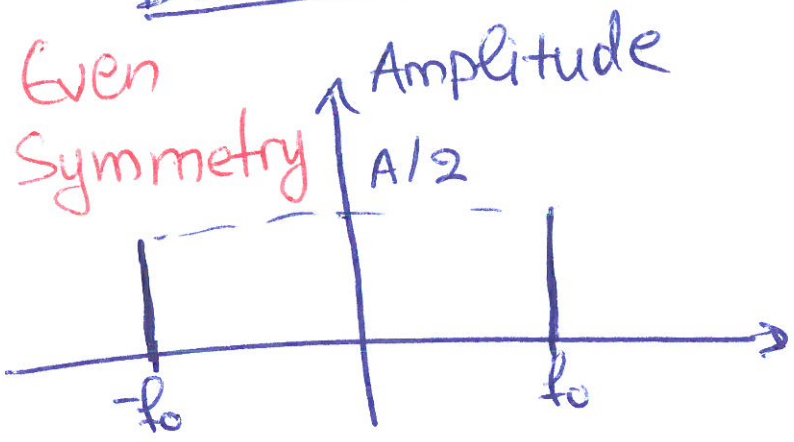
$$x(t) = A\cos(\omega_0 t + \theta)$$

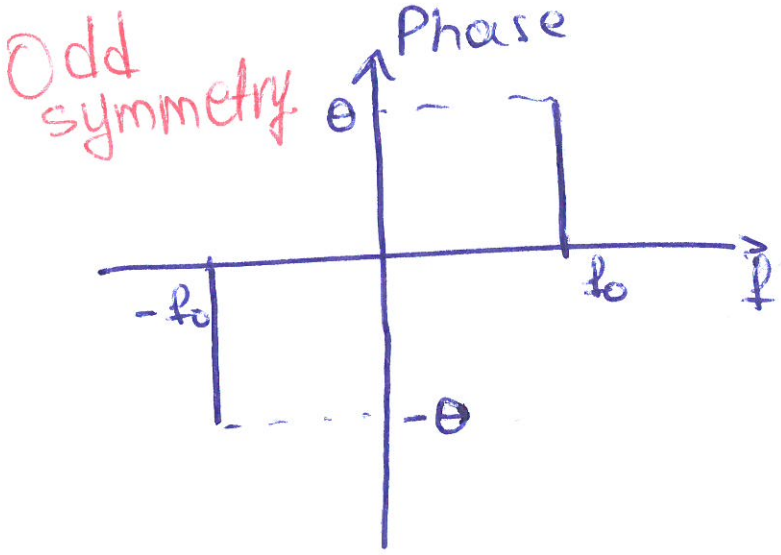
Single-sided





Double-sided





Example:

$$x(t) = 2\sin\left(10\pi t - \frac{1}{6}\pi\right)$$

$$= 2\cos\left(10\pi t - \frac{1}{6}\pi - \frac{1}{2}\pi\right)$$

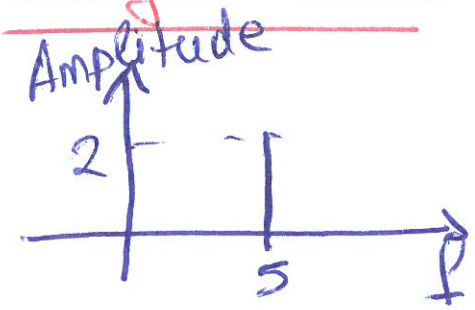
$$= 2\cos\left(10\pi t - \frac{2\pi}{3}\right)$$

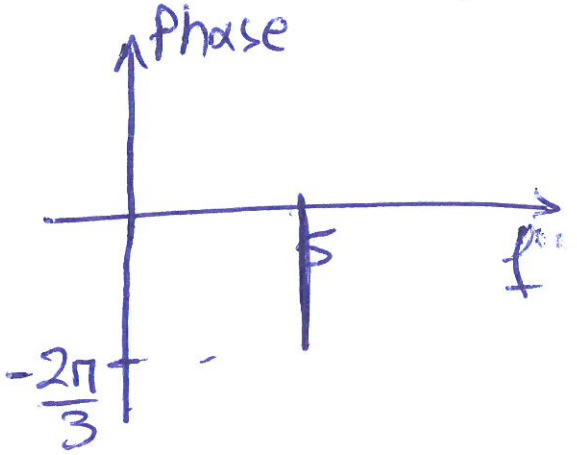
$f = 5\,Hz$

$\theta = -\frac{2\pi}{3}$

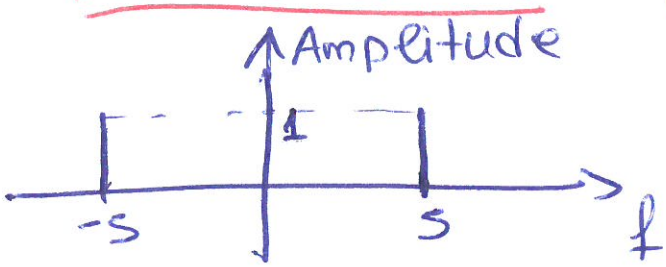
$A = 2$

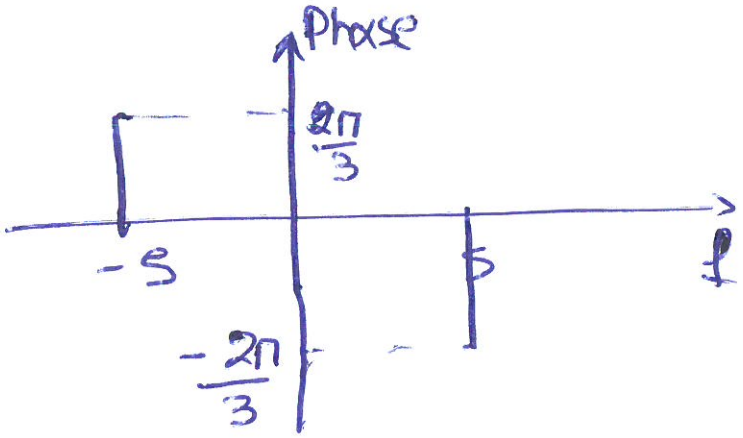
Single-sided





Double-sided





Example 2

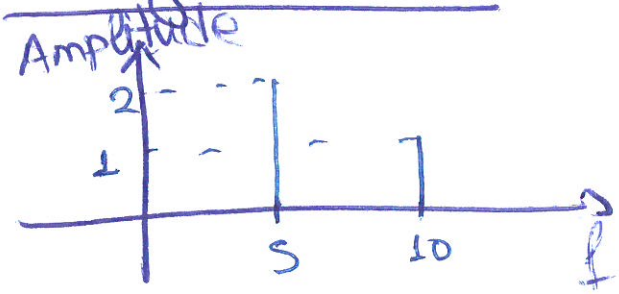
$$x(t) = 2\sin\left(10\pi t - \frac{1}{6}\pi\right) + \cos(20\pi t)$$

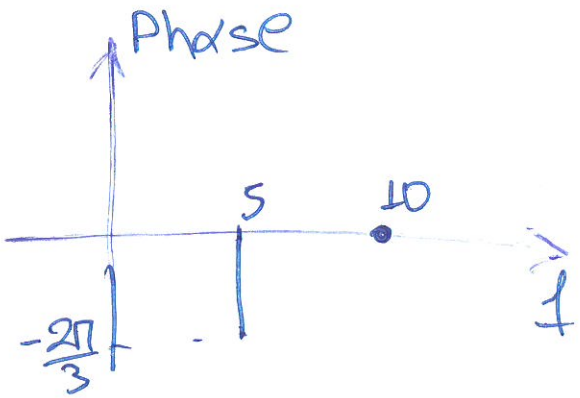
$$= 2\cos\left(10\pi t - \frac{2\pi}{3}\right) + \cos(20\pi t)$$

$A = 2$
$\theta = -\frac{2\pi}{3}$
$f = 5\,Hz$

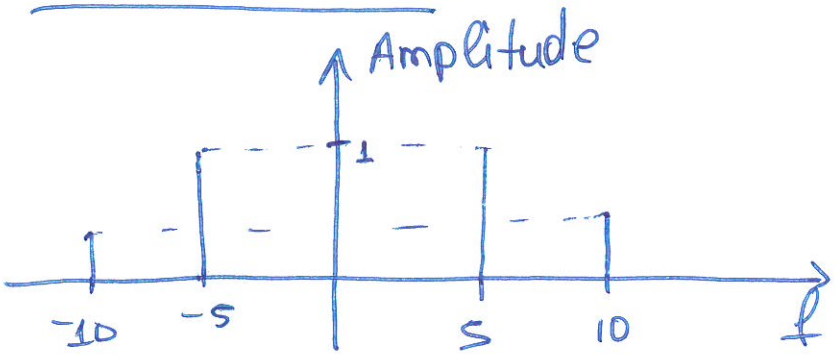
$A = 1$
$\theta = 0$
$f = 10\,Hz$

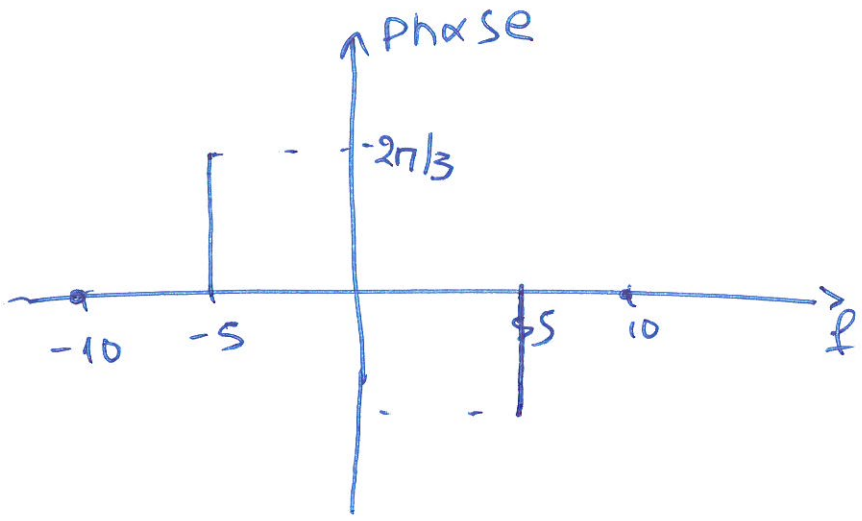
Single-sided





Double-sided





Read pg: 1 - 21